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| **Lesson Title: Asthma and Your Genes** |
| **Subject area / course / grade level:** Genetics and biotechnology/ biology/5 and 6 |
| **Introduction:** Asthma affects over 8% of the population in the US, that is over 24 million people (Akinbami, 2011). Albuterol is a commonly used asthma medication that acts on a protein in the lung called Beta2AR The “recipe” for this protein is found in your genes. The ‘recipe’ is written using 4 nucleotide bases (A, C, G, T). Some locations will have the same base ‘letter,’ while others will have a different base ‘letter.’ These differences from one person to another are called single nucleotide polymorphisms (SNPs or “snips”) and they help make you the person you are. The block of variation ‘all-together’ is called a haplotype. By looking at which haplotype/variations a person has near the Beta2AR gene (by sequencing their genes/DNA), a physician can predict a patient’s response. Patients fall into one of three groups: good responders, non-responders, and adverse responders. Being a non-responder is as bad as being an adverse responder because both are in danger. |
| **Lesson Length:** 50 minutes |
| **Materials:** DNA sequence handout, pencil, highlighters, scissors |
| **Lesson Overview:**  This lesson uses genetic and drug response data to allow students to make predictions about a drug reaction based on genetic information. The lessons targets new technology using a real-world scenario that is based in genetics and biotechnology. |
| **Tennessee Standards:**  GLE0507.Inq1, GLE0507.T/E.2, GLE0507.T/E.4  GLE0607.T/E.3 |
| **Lesson objective(s):**  Students will learn how new technology and information can influence health and health care  Students will learn that gene variation can affect an individual’s drug response (personalized medicine)  Students will observe patterns in genetic data and medical outcome to make a predictive chart  Students will learn to make predictions as to the medical course of action based on genes |
| **ENGAGEMENT**   * Describe how the teacher will capture students’ interest.   Personalization: Instructor asks, “Who in class has or knows someone with asthma? Have you seen them take their medicine? What does it look like? What happens if they don’t have their medicine?”   * What kind of questions should the students ask themselves after the engagement?   What other kinds of tests are there for other medicines?  Has my friend/family member with asthma ever been tested?  Can my doctor test me? |
| **EXPLORATION**   * Describe what hands-on/minds-on activities students will be doing.   Students will be observing patterns in multiple types of data (drug response, genetics) to make predictions about an unknown case. The data results from new technology and relates to how technology is changing society, including medicine.   * List “big idea” conceptual questions the teacher will use to encourage and/or focus students’ exploration   What can your genes predict about you?  What can’t your genes predict about you?  What do you think technology will allow us to do in the future? |
| **EXPLANATION**   * Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination?   The DNA sequence data can be given to the students, who are asked to find patterns. They should be able to see there are certain letters (SNPs) that differ, others don’t, and that they are arranged in blocks (haplotype).  The students can then be given the table that shows correlates person to albuterol response. They can then connect the person’s genes to the type of albuterol response.   * List higher order thinking questions which teachers will use to solicit *student* explanations and help them to justify their explanations.   How would your prediction for the “unknown” person change if the genes had shown… (another sequence)? [yes, depends on which one you pick]  Do you think this gene sequence would be ok to use for other medications? [no, different proteins/genes for other medications]  Do you think the parents of a good responder might also have a good response? Why? [genes are inherited, so this patient received her/his genes from them] |
| **ELABORATION**   * Describe how students will develop a more sophisticated understanding of the concept.   They will be constructing knowledge based on patterns in data and then USING those patterns to make predictions.   * What vocabulary will be introduced and how will it connect to students’ observations?   Single nucleotide polymorphism (SNP) – a variation in the gene sequence  Haplotype – a block of gene sequence that is inherited as a single unit   * How is this knowledge applied in our daily lives?   This is the future of personalized medicine – treatments based on our genes rather than on making guesses about which, of several, medications will be helpful. It is a real world scenario into which they can fuse their foundational knowledge (medication, asthma) to new technology and its uses. |
| **EVALUATION**   * How will students demonstrate that they have achieved the lesson objective?   They should be able to construct the pattern and make an accurate prediction. If the instructor changes the “unknown” gene pattern, they should be able to select the correct prediction.   * This should be embedded throughout the lesson as well as at the end of the lesson |

Akinbami LJ, Moorman JE, and Liu X. 2011. Asthma prevalence, health care use, and mortality: United States, 2005-2009. National Health Stat Report. 12(32): 1-14. Abstract available at: <http://www.ncbi.nlm.nih.gov/pubmed/21355352>

Relevant links:

Pharmacogenetics Activities

<http://learn.genetics.utah.edu/content/health/pharma/>

Asthma affects over 8% of the population in the US, that is over 24 million people (Akinbami, 2011). Albuterol is a commonly used asthma medication that acts on a protein in the lung called Beta2AR The “recipe” for this protein is found in your genes. The ‘recipe’ is written using 4 nucleotide bases (A, C, G, T). Some locations will have the same base ‘letter,’ while others will have a different base ‘letter.’ These differences from one person to another are called single nucleotide polymorphisms (SNPs or “snips”) and they help make you the person you are. The block of variation ‘all-together’ is called a haplotype. By looking at which haplotype/variations a person has near the Beta2AR gene (by sequencing their genes/DNA), a physician can predict a patient’s response. Patients fall into one of three groups: good responders, non-responders, and adverse responders. Being a non-responder is as bad as being an adverse responder because both are in danger.

1. Some Beta2AR gene sequences are the same and others are different for 14 asthma patients below. Use a highlighter to highlight the columns that are different, then cut the page into strips and group similar patients’ genes together. How many different groups are there?

|  |  |
| --- | --- |
| Patient | Gene sequence |
| 1 | CTGACTAAGTACCGA |
| 2 | CCGACTAAGTACCGA |
| 3 | CTGACTAAGTACCGA |
| 4 | CTGACTAAGTACCTA |
| 5 | CCGACTAAGTACCGA |
| 6 | CCGACTAGCTACCTA |
| 7 | CCGACTAAGTACCGA |
| 8 | CTGACTAAGTACCTA |
| 9 | CTGACTAAGTACCGA |
| 10 | CTGACTAAGTACCGA |
| 11 | CCGACTAAGTACCGA |
| 12 | CCGACTAAGTACCGA |
| 13 | CCGACTAGCTACCTA |
| 14 | CTGACTAAGTACCTA |

2. Based on the patients’ variations (SNPs) (left) assign each patient to a block type or ‘haplotype’ group (right).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SNP variation** | **Block type or**  **‘Haplotype’** |  | **Patient Data** | | | | | |
| -T-----A-----G- | a |  | **#** | **haplotype** | **response** | # | **haplotype** | **response** |
| -C-----A-----G- | b |  | **1** |  | none | **8** |  | good |
| -T-----A-----T- | c |  | **2** |  | good | **9** |  | none |
| -C-----G-----T- | d |  | **3** |  | none | **10** |  | none |
|  |  |  | **4** |  | good | **11** |  | good |
|  |  |  | **5** |  | good | **12** |  | good |
|  |  |  | **6** |  | bad | **13** |  | bad |
|  |  |  | **7** |  | good | **14** |  | good |

3. Reorganizing the data in the table below will help you identify which gene/SNP variations show good, no, and bad responses to albuterol.

|  |  |  |  |
| --- | --- | --- | --- |
| **SNP variation** | **Block type or**  **‘Haplotype’** | **Patient Numbers (1-14)** | **Response** |
| -T-----A-----G- | a |  |  |
| -C-----A-----G- | b |  |  |
| -T-----A-----T- | c |  |  |
| -C-----G-----T- | d |  |  |

4. A patient complains of shortness of breath while exercising and you diagnose her with exercise-induced asthma. You send a sample of her DNA to the lab for sequencing. You receive the results (-C-----A-----G-). What is her haplotype? Would you prescribe albuterol for her asthma? Why or why not?